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## Computers, humans may be linked in future wars

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**By Bruce Lieberman**

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Enemy jets materialize on the ship's radar screens like swarms of fireflies. Pilots scramble, and the skies fill with both friendly and hostile aircraft.

Sailors quickly identify each blip, issue warnings and launch missiles toward the adversary.

Shipboard computers monitor the battle – but they also watch the radar operators.

Sensors gauge their blood pressure, heart rate and respiration. They track where on the screens the sailors are looking, how hard they are thinking and which parts of their brain are reaching their limit of endurance.

Sensing that one sailor is overwhelmed, a computer changes the display on the screen, showing only the aircraft that pose the gravest threats. Setting priorities and keeping track of the action, the computer then transfers several tasks to a sailor nearby.

This scenario, the stuff of science fiction, is one of the Pentagon's high-tech visions for how humans and computers will work together in combat.

Scientists and engineers at San Diego State University and two local companies are participating in a project to transform the way the Navy fights.

They are among several institutions and firms under contract with the Defense Advanced Research Project Agency, or DARPA, the Pentagon's research division.

"Cognitive computing systems will have the ability to reason about their environment, their goals and their own capabilities," the agency's director, Anthony J. Tether, told Congress in testimony last month.

Someday, such advanced technology could be incorporated into Navy ships, unmanned aircraft and military vehicles, and be carried by the combat soldier.

The Defense Department long has been interested in how highly trained military personnel make complex decisions under stress.

The subject received particular attention after two Iraqi missiles hit the frigate Stark and killed 37 sailors in 1987, and then a year later when the cruiser Vincennes accidentally shot down an Iranian airliner which it

mistook for a fighter jet.

The new program is managed by DARPA's Augmented Cognition initiative, a \$19.1 million effort this fiscal year that aims to find ways for computers to boost the brain power that military personnel bring to battle. The Pentagon hopes to test prototypes of such technology within five to 10 years.

Tether outlined some of the challenges.

Computers "still require the user to adapt to them, rather than the other way around," he said. "Computers have grown ever faster, but they remain fundamentally unintelligent and difficult to use. Something dramatically different is needed."

Forty years ago, computer science pioneer J.C.R. Licklider envisioned a day when "human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain has ever thought."

At SDSU, engineers are experimenting with technology that will link humans to the computers they are working on.

In the laboratory of psychology professor Sandra Marshall, student volunteers sit at a computer terminal that simulates a radar screen aboard an aircraft carrier.

As jets appear on the screen and threaten the ship, the students must quickly identify them, issue warnings and fire on planes that don't respond.

The computer presents increasing degrees of difficulty, from a few aircraft on the screen to swarms of them approaching from several directions.

Sensors attached to the volunteers continuously measure heart rate and blood pressure. The students also wear a headset equipped with tiny cameras that track where on the screen their eyes are moving.

Other instruments include an electroencephalogram, or EEG, to measure electrical activity in the brain, and functional near infra-red sensors, called fNIR, which create images of activated areas of the brain.

More than 30 instruments were attached to the volunteers in one recent experiment.

"We literally had people wired from head to toe, and we were . . . able to collect some excellent data," said Chris Berka, whose Carlsbad company, Advanced Brain Monitoring Inc., has developed a wireless EEG that volunteers wear as headgear.

Marshall also runs a company, EyeTracking Inc., that has developed technology to measure rapid changes in pupil dilation. Scientists have long known that pupils dilate according to increased interest or arousal.

"What we're seeing are these very short bursts of activity, and they correlate very nicely with things like the difficulty of tasks," Marshall said. "It's a pure reflex."

Dilations, which can occur several times a second, also vary from eye to eye – signaling cognitive effort in the right and left hemispheres of the brain.

The left hemisphere is thought to be the language center of the brain, and processes information in logical and sequential order.

The right side of the brain is more visual and processes intuitively, holistically and randomly.

Eventually, researchers plan to constantly feed information from the sensors into a computer, which will then use that information to adjust how it presents information, and how much.

The computer "will know and support the actual state of the user, rather than just infer the user's state or intentions," Tether told Congress.

The military plans to apply this technology far beyond the Navy, said Jeffrey G. Morrison, a scientist with the Navy's Space and Naval Warfare Systems Command in Point Loma.

As unmanned aircraft become more common, the demands on their human operators will increase.

"Instead of having two pilots for one aircraft, you could have two operators for six aircraft," Morrison said. "That represents some really interesting challenges for task management."

In military vehicles, new computers will be engineered to monitor what their drivers are paying attention to, and to warn them of impending threats.

Finally, technology is being designed to help infantrymen make decisions in the field. The Army is developing a helmet-mounted computer that will display graphics, digital maps, intelligence information, troop locations and other imagery.

"They need the most help, but they're the hardest to find solutions for if they have to wear this stuff and carry it around," Morrison said.

Technology based on augmented cognition could be incorporated into warships, aircraft, vehicles and directly with combat soldiers, at least in prototype versions, in the next decade, Morrison said.

Marshall said great engineering advances are needed before that day comes.

"The challenge remains miniaturizing things enough to make them useful," she said. "We'll need some breakthroughs."

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